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THE PROTECTION OF MINERS.

BY ANDREW ROY.

It is now more than twenty years since the laws for the inspection of mines by the authority of the State were enacted. At that time, and for several years afterward, no other State had such laws, except Pennsylvania, which provided for the inspection of anthracite mines only. The enactment of the Ohio mining laws was the outcome of a long and bitter fight between the miners and the operators—the latter assailing the proposed law as an invasion of their property rights. They insisted that the mines of Ohio were not deep enough to be dangerous; and pointed, with reason, to the fact that the State of Pennsylvania had declined to include the bituminous mines in the law when legislation for the protection of the health and safety of anthracite miners was enacted.

The first bill on the subject of protecting Ohio miners was prepared by a committee of practical miners. It provided for four inspectors, who should be required to pass a satisfactory examination and receive certificates of competency, before assuming duty. The bill was, however, after a contest of three years, emasculated in many important provisions, in its final passage through the general assembly; and only one inspector was allowed. The only remedy to compel obedience to the law was by injunction; and in this condition it remained for seven or eight years, when one assistant was added.

When the law was enacted, March, 1874, the condition of the mines as to ventilation and general security was very defective. There was not a ventilating furnace in the Hocking valley mines; nor any mine boss there except one, who had ever seen a furnace, or fan, or any appliance for providing artificial ventilation; and in no region of the State was there any furnaces in use, capable of moving five thousand cubic feet of air per minute, except in the Steubenville district, and at one or two other points. Fan ventilation was unknown. The deepest mines had but one opening, and the majority of shafts but one means of ingress and egress. There were no safety gates, nor covers or cages, except at a few mines.

For some years, or until other mining states followed Ohio

in providing for official supervision of mines, the law was grudgingly obeyed. Every mine having but one means of escape had to be enjoined or complained against, and in numerous other cases the remedy of injunction had to be resorted to, to compel obedience to the law. As there was but one mine inspector, and there were three hundred and six mines that came under the provisions of the law; and as many of the mine bosses were grossly ignorant of the art of ventilation, and of everything in fact pertaining to good mining practice, the position of a mine inspector in those days was not an enviable one.

The promoters of the mining law had two principal objects in view, namely, systematic perfection in ventilation, and two separate outlets to mines. These provisions they considered the very soul of the law, compared with which all other provisions might be regarded as the limbs and outward flourishes. The subject of mine ventilation received more attention at the hands of the committee of mines than any other. All interference with the management of mines was carefully avoided, except such as were absolutely necessary for the proper protection of the lives, health and safety of miners.

As soon as possible after the law took effect artificial ventilation by furnaces and fans was provided, and greatly increased quantities of air made to flow into the mines. But while the sanitary conditions were greatly improved, the inspector found endless trouble to get the mine boss to maintain good ventilation at all the working faces where the people were employed. The airways of mines were frequently overhauled, stoppings made air tight; but as the inspector could only make one visit to a mine in a year, on an average, neglect soon followed, stoppings settled and leaked air; break-throguhs were not closed up as newer ones were made; and the remedy of injunction wrought injustice in many parts of a mine; for even in the worst cases there were working places above all complaint.

Notwithstanding the increase in the number of inspectors, from one to eight, and the amendments to the law requiring break-throughs to be made every sixty feet, and giving the inspectors the power and making it their duty to bring offenders against the law before a magistrate, the miners are still found in sections of many mines enveloped in a stagnant atmosphere reeking with mephitic vapor and blinding volumes of powder smoke. The pressure of the laws as they now stand on the statute books require the owner or agent of every mine to provide and maintain not less than one hundred cubic feet of air for every person employed under ground, which shall be cir-

culated so that the ventilating currents shall sweep the innermost break-throughs at or near the faces of the workings, and that all break-throughs except those last made near the working faces shall be closed up and made air tight, so as to enable the current to sweep out the poisonous and noxious gases from each and every working face in the mine and render them harmless.

If the inspectors in visiting mines, instead of merely calling attention to violation of the mine law and asking that bad conditions be improved, were to cause the guilty parties to appear before a magistrate to be fined or imprisoned, or both, as the law directs, there would be some improvement in ventilation and in other neglected parts of the law. As a matter of fact it is the exception rather than the rule to close break-throughs between rooms. If half of the stream of the air required by law were made to sweep the innermost break-throughs, neither stagnant air, nor mephitic vapor nor powder smoke would be found in a single working place in any coal mine in the State. How many mine inspectors find an air current strong enough at the interior break-throughs between rooms and entries on the return air courses to even move the vanes of their anemometers?

The faulty conditions of ventilation which prevail at many mines are due to the faulty systems, or rather to the lack of all systems, in the manner of laying out the workings. To properly enforce the law at such mines, as inspection is done, would require an inspector to visit their workings at least once a month—in some cases once a day would be necessary.

The advocates of the mining law held that its requirements as to the ventilation and general security would in no long time bring to the front a superior class of mine officials and improved methods of mining and ventilation. But while in the larger mines such has been the case very generally, it is a melancholy fact that after twenty (20) years of inspection many mines are still worked and ventilated on systems which existed one hundred and fifty years ago. Coal is lost beyond recovery; bad air prevails over large areas of the mine; the inspector points out the defective conditions; the boss makes a spasmodic effort at improvement, and soon things are as bad as ever. If the double entry system were adopted, leaving pillars at least fifteen feet thick and thicker in proportion to the increasing depth of strata; closing all the break-throughs along the air courses of the mine with wood and brick stoppings, and carrying the works and air systematically forward, it would be easy to maintain a constant flow of air at the innermost break-throughs. Every practical miner and mining engineer of good intelligence agrees that by the double entry plan it

costs less in the long run to get coal than by the gouging systems so often met; though it may cost considerably more in the beginning. Rooms could be driven eighty yards and only one break-through needed to each room, which would not have to be closed at all, because as the squares of work advanced the air could be taken from the worked out area and kept playing where the people were employed. In drawing pillars also, all the pillar coal could be mined as the workings advanced progressively forward, except in rare cases.

The following suggestions are offered, believing they would result in better methods of mining and ventilation than those which still exist at many mines. All mine bosses and mine inspectors should be required to pass a satisfactory examination and receive a certificate of competency, exception being made in favor of bosses and inspectors who have had three years' practical experience as such. An operator, however, in selecting a mine boss should be allowed to choose any miner, whether he had then a certificate or not, but such boss should be required to procure his certificate at the first meeting of the board of examiners. All the mine inspectors—chief and district—ought to hold certificates to be eligible for office.

When an inspector examines a mine he should be required to post up in a conspicuous place at the mine, as the weight sheet is posted, a statement of the condition of the mine, and in what manner and place he found the various departments complying with or disregarding the law, and he should not hesitate to proceed against all violators of the statute before the proper magistrates.

There are now in the State University three professors of mining engineering, all men of good, practical and scientific attainments, who, with the addition of two competent, practical miners, should be organized into a state board of mines by law; to meet twice a year, before which all applicants for the position of mine boss and mine inspectors should be required to appear and obtain certificates of competency after a satisfactory examination. The Colliery Engineer, which has done and is doing so much for the education of practical miners, for improved methods of mining and ventilation, and for general security in mines, has this to say in the January number, touching some proposed amendments to the Colorado mining law: "A mine law without certificated mine officials is of comparatively little value. This has been demonstrated by the experience of all civilized mining countries. An examination of British coal mining statistics, which cover a longer period than any other land, shows that with careful mine inspection and no certificated mine officials, the fatalities in British

mines averaged one to every three hundred and twelve employes. Since the enactment of the law requiring certificated mine officials the fatalities have averaged one for every five hundred and thirty-three employes. In other words, the occupation of the miner has become 80 per cent. safer." (Applause.)

MR. ROY: The idea I intended to add was that it might be a good thing for a mine inspector, when e visits and makes inspection of a mine as to ventilation, to have a blank form and note down the condition of the mine as to ventilation and general condition, and post it in a conspicuous place so the miners can see it, as well as they see the daily record of the amount of coal put out. There is another matter I want to speak about, but as I am not a good talker I would rather write it down and read it.

PRESIDENT ORTON: We have all listened to Mr. Roy's paper with much pleasure, and await with interest his paper to-morrow. It was in his little office in the first story of the State House that we first got together and we were fewer in numbers then than we are to-day. I was present and well remember the impressions made on me at that time.

Are there any remarks on Mr. Roy's paper? It is certainly a subject on which miners ought to have plenty to say,—suggestions for the improvement of mine inspection.

MR. HARRY: There is evidently a difference of opinion here. Mr. Roy says the bosses must be educated and pass an examination, and Mr. Short says the only man who knew his business was a man who had no education at all.

MR. SHORT: Let me say to Mr. Harry that I only pointed out one man from one hundred and thirty who lacked the education to write his own name.

MR. HARRY: You would find some more of them.

MR. SHORT: I presume so, but I did not intend to convey the idea that a man without education was best fitted for these places.

MR. LOVE: I quite agree with Mr. Roy in his ideas of mine

inspection, but differ with him in some respects. It is true that all the mines in Ohio are not as nice as they ought to be, or as well ventilated as they ought to be. But compare them with other states, and I think we are able to defend that question. It has been ably discussed here by men who were able to discuss it, prior to this meeting, and I don't think it is necessary to touch on that. While he speaks of reform in mining and the good done by modern systems, he recommends now as an improvement, the double entry system. I think you cannot ventilate a mine properly on the double entry system. If it is true that the fault lies in the method of mining, the inspectors should be given their share of the blame and so should the mine boss; but it is true, that as long as there are mines there will be accidents. That has been the history of the country referred to; and I assure you, without fear of contradiction, that the number has been greater there than here. And so it is in Pennsylvania, where they have certificated mine bosses and inspectors. They don't have very many more dangerous elements to contend with than we—they are very numerous here in Ohio. But I will not dwell on the subject. I liked the paper very much, and think it was intended to do good. I don't think there is an inspector present but would be perfectly willing, if it is the will of the mining fraternity, to undergo that examination.

PRESIDENT ORTON: Are there any further comments on the paper?

MR. JONES: I would like to inquire from Mr. Roy as to how under the double entry system, he can sweep out of the working faces of the miners these obnoxious, gases, or the smoke which is the result of the discharge of powder?

MR. ROY: You will find that prevails. I have gone through mines where the air carried it forward—where the smoke did not last two minutes. It moved away at the rate of the air current, so it could not stay. I think there are quite a number of mines in Ohio that justify what I say.

MR. JONES: I have seen that experiment tried in the district that I have the honor now to preside over, when I first as-

sumed the duties of district mine inspector, in the No. 6 seam. We had great difficulty there in securing a pure air, or approximately pure air for the miners to work in. Now, the difficulty was that they were in the habit of firing at noon every day, and blasting No. 6 coal from solid required an extraordinary and unusually large blast of powder. I contended that all that was necessary was to get sufficient air in the mines and place check doors at appropriate places on the entries, and the smoke would come out. I proceeded to elaborate on that theory at the meeting of the mine bosses, and the superintendent says, "try it"; and in a mine that produces twenty-seven thousand cubic feet they erected check doors on every entry and forced the air in. While the air was immediately forced through, it failed to take the smoke out. After the air got up ten or twelve yards, then the smoke remained there stationary, and it required an effort by the men to brush it into the air current so it would be taken away.

MR. ROY: How much air was moving through the break-through?

MR. JONES: All of it.

MR. ROY: That is the first time I ever heard that statement made.

MR. LOVE: I would like to say that I am like Mr. Roy,—I can't think of everything at once. But he must take into consideration that while the methods of mining have been improved, so has ventilation, and as fast as ventilation is improved, powder is used to excess. I agree with Mr. Jones, that I am satisfied that double entry mines cannot be ventilated and kept free from smoke, when the price of mining is sixty cents a ton, when instead of the pick doing the work, now the drill and powder does it. There is a mine in my district employing a hundred miners, where inside of an hour at noon they exploded five hundred pounds of powder. They could not stay at the room faces or go back to work for an hour, and there was twenty thousand cubic feet of air in circulation, more than the minimum.

MR. ROY: Was that circulated through where the smoke was?

MR. LOVE: Through the break-throughs.

MR. ROY: Do you mean to say that there is twenty thousand cubic feet of air going through any break-throughs in Ohio?

MR. LOVE; No; I mean it was well circulated and each had its share. Now, it is proposed that the miner goes sixty feet in advance of the break-through. The stronger you make the current, the more it backs the smoke up to the face. Now, then, is it the fault of the law, the fault of the inspector, of the mine boss, or of the system? I think if you will go through these mines with us, you will find it is the system.

MR. KANE: What system do you refer to?

MR. LOVE: I refer to the double entry system, which is almost the only system working in Ohio. It is an improved system over the single entry,—there is not so much waste air; but when a miner is sixty feet in advance of where the current is, he can't get the advantage of it.

MR. ROY: What would you substitute for it?

MR. LOVE: I'll tell you when I read my paper. The same subject has been discussed here. There is a mine in my district where the air is carried within six feet of the face, and the air is so charged with gas they can't go in advance of the break-through fifteen feet, hence they must carry brattices there. Now, if there is a man here from Salineville and this is not true, and if it is not true of No. 4 mine at Sherrodsville, I want him to contradict me. If it isn't well conducted to the face I want it to be disputed. And yet in that mine the miners suffer from powder smoke, and in that mine there is a current of more than one hundred cubic feet of air.

MR. ROY: I suppose we all agree that the same laws govern the removal of powder smoke that govern the removal of fire damp, and all the people of the world put break-throughs up near

the faces to get rid of the gas. The idea that the least air going through the working face, the better the ventilation, is all a mistake. Somebody referred to the organization of the mining institute, and I believe I have had more to do with getting the mining law passed than anybody. I was three years working at it and read all the books bearing on the subject that I could get. I have mined coal in seven states in the Union, besides as a little boy I worked in the mines in Scotland, and I was always given to understand that the more air near the working face at the mine, the more powder smoke you will get rid of. There is not a mine in Ohio, nor in Pennsylvania, nor perhaps a mine in the world where ten thousand cubic feet of air is playing along the face of the room. We could not stand it. At Steubenville, where there is better ventilation than almost anywhere in the State, I have measured the currents,—have gone in and out and always found enough air going through the break-throughs to move the anemometer, and when the last break-through was made there was so much air that the men took cold by it; but they got rid of the smoke faster than where there was less air. If the whole teachings of my lifetime and the work of the best years of my life go for naught, I beg pardon for what I have done wrong.

MR. HARRY: I say it is a mistaken idea to close up all the break-throughs and force the air through one. I don't think there is any mine that could carry twenty thousand cubic feet of air through the break-throughs, except the largest. Your proposition was to use that much air and close up all the break-throughs, and I claim it is not practical to close up all the break-throughs and carry all the air necessary in the mines in southern Ohio.

MR. WEST: It seems somewhat paradoxical in regard to this matter, but yet experience teaches me that natural conditions of the mines have much to do with ventilation. I find that where we convey all the air of the mine along our entries, especially on the butt entries, and we have about ten thousand cubic feet per minute, and if we hang a check door at the first room, when the first room is thirty or forty feet from the first break-through, I

find the powder smoke hangs about for a matter of two or three hours—with ten thousand cubic feet of air and a check door.

MR. JONES: I am sorry if the observations of my colleagues and myself run counter to the experience of anybody. There is one thing in which a friend like Mr. Roy has the advantage, and that is he can relate the experiences of a long lifetime. The young man cannot do that very readily. I have sometimes thought, however, that a recital of these details may have the charm of reminiscences about them, but at all times it does not necessarily follow that any more importance is associated with them. I would like to ask my friend Roy this question. Would you enter a mine, or a room in a mine, the face of which we will say is fifty feet in advance of a break-through, and presumably ten thousand cubic feet of air passing through that room at the time, if the room was full of carbureted hydrogen gas? I venture to declare that there is no man here who would enter into his room or entry in his mine, knowing there was gas therein, even knowing there was all the air possible passing through the break-through fifty or sixty feet behind it. The logic is this: where you have a large volume of air passing through the break-through, it has a tendency to beat the smoke back to the face and preclude the idea of it being wafted away. The experience I detailed occurred at Summerdale in Tuscarawas county, and the men were compelled to take their coats and waft the smoke into the current. The statement made is slightly misleading. If there were forty thousand feet of air passing through and if the face be twenty or thirty feet past a break-through, no man would dare to enter. If he did it would be the last time. Why? Because if he did the spark of life would snap out. I want to say that no man in Ohio, and no man anywhere, where there is fifteen thousand feet of air playing through the entry and room, where there is gas, would dare enter, for it would not be wafted out.

MR. ROY: There is a good deal of allowance to be made about those currents of air. I have measured air again and again and have never found that, and I venture to say none ever found

that. I don't know how you got the measurements, but I know there is no such current going, gentlemen.

MR. JONES: I concede the right to ask questions, but I draw the line at a man proceeding to make speeches on my time. There may be a large volume of air traveling in an air course, and say for thirty or forty feet there may be a room, and the room may be generating fire damp, and I submit that it is no peculiar circumstance that the fire damp refuses to come out and be wafted away in the air current. But if you went at it properly to induce the fire damp to come out, it is necessary, as they do in England, to take your canvas or brattice and waft it along. If fire damp will come out in the air, then why in a large mine in England generating gas do the men carry up behind them brattices? That experience, like my friend Roy's, may go for naught.

MR. KANE: I believe this question has been very intelligently,—or unintelligently, I don't know which—discussed in one particular phase of it. But it seems to me when past and present mine inspectors will consume so much time in discussing a question of such vital importance, and contradicting each other, that Mr. Roy is right in saying they ought to be certificated. I want to give my personal experience, and I give it because I think it is needed. Now, if I understand Mr. Roy right, he is right. If I understand him (and I fear Mr. Jones partially misunderstands him), he means to say that the break-through should be near the face, in the first place, and the more air passing, the less danger from gas or any other noxious matter.

MR. ROY: That is it.

MR. KANE: That being the case, that is exactly equal to what Mr. Jones said they did in England, only in another form. They merely carry the brattice up, and in this case the pillar itself is the brattice and is closed, just as the brattice itself would be if taken.

A MEMBER: How do you keep the break-through close to the face?

MR. KANE: The brattice is never kept close up to the face,—within six feet, and I have seen them farther away than that. It is possible to keep the break-throughs nearly that close, though, if you want to have sufficient break-throughs. There is one point that ought to be established, that the more air you have the less danger of anything unless, as Mr. Jones said, there is gas in the air and carried with the air, and a man is carrying a safety lamp, and a large current would drive the light outside of the gauze of the safety lamp,—then, in that case it would be dangerous. You are arguing presumably on the pre-existence of stationary gas. You continue a good current of air and you will not have to go into the room face and take your coat and waft the gas out of the face. In case you have a break-through a good ways from the face of the room or entry and a block of gas gets right up in the face there, I think it would be wise to go up and waft it out; but if the break-through is close to the face and there is a good current of air sweeping through, you don't need any coats or anything, because the air will drive it out in spite of everything.

With regard to the smoke,—of course that was a very large amount of powder which Mr. Love spoke of as having been used. Five hundred pounds is a large amount of powder and it may be that that large amount could not be driven out very soon, no matter what amount of air you had. But I do know by personal experience,—and if there is any man here who has worked in the County of Durham, England, they know,—and I appeal to them, that all that is necessary under their system, which is similar to that I mentioned and Mr. Roy is standing up for,—all that is necessary is to have the conditions I described. They work short hours there and take three or four minutes to eat lunch, and when they go back in three, or four, or five minutes, there is not a vestige of smoke. What is done there can be done here under the same circumstances.

There is another phase of this question, though, which was raised by Mr. Short and substantiated or strengthened by Mr. Roy, and that is that under all this thing there is somebody suffering and that "somebody" is the miner, who has to bear those nasty,

foul and health-robbing vapors and gases. Your laws, I believe, are adequate if they were executed. I don't believe there is hardly any necessity for improvement in the law. They might be improved to good advantage, but if executed as they should be, those men would not have to suffer, as evident from Mr. Short's and Mr. Roy's testimony they do suffer.

I understand Mr. Love introduces the feature into the discussion that, as he says, the powder is digging the coal. I know when I was digging coal I used powder to advantage. I knew that when I got a certain amount of lump coal I got a certain amount of money: when it was less, there was less money. When I used less powder, there was less lump coal, and less money. There are a few exceptions to that rule, but it is the rule and I know very well that from a selfish standpoint of personal interest, miners will not use more powder than is to their advantage, unless operators introduce unskilled men for the purpose of depressing the more skilled men there before them.

All of that is nothing with regard to the main feature of this subject. If the law is good enough, it may be that there isn't sufficient power given to execute it. If there is not, there should be. The question reduces itself to this: if there isn't sufficient power given to the mine inspectors to execute the law, right here at this meeting of this Institute, you men who have the experience, who have technical knowledge, ought to see that the law is changed so that your inspectors have power. If you have the power, you are evidently not using it. If you have the power and are not doing your duties, you should be censured. Of course, I believe the power to execute the law is not sufficient. I don't believe that any of you men who may go to a mine and find anything wrong have any power whatever to put it right. Of course the intent of the law is all right; but when a law is passed saying that such and such a thing shall be done, and giving no power to anybody to see that it shall be done, it is a fiasco, a miserable farce and useless. And I think a meeting of this kind should look into that aspect of the case and see what is wrong and attempt to have it put right.

MR. ROY: The state of feeling among the people in my county regarding the accident I spoke of, was pretty high. The mine was within a mile and a half of the present inspector, and I am told that there is a mine near there which had been running for two or three years, and the inspectors had visited it, and it had no safety gates until after this accident. Now, I don't say that it is true, but I say the miners say it is true.

MR. BEATTIE: I desire to ask a question,—whether this meeting was called for the purpose of censuring the mine inspectors?

SECRETARY HASELTINE: Mr. Roy's paper is one that is very proper and has brought out a great deal of discussion here; and I want to say now that I am not "hot" about it—he is always blaming me with getting "hot." Mr. Roy evidently has not kept pace with the procession. He says he had three hundred and seventy mines and one assistant: we have over a thousand mines and eight assistants. I visited the mines in the Mahoning valley continuously for fifteen or seventeen years, and was with the men who worked in them. The powder used at that time did not make one-fourth the smoke that it does to-day. Another element that he has not kept track of, is that the miners are burning petroleum oil instead of lard oil and candles, and there is a set of men making a business of doctoring miners' oil. I have been at them, trying to stamp them out, but as fast as I get them stopped in one place they break out in another. There are very many disadvantages of which he seems ignorant. There are more mines in Jackson county worked on the single entry system than any other, and my friend Kane and Mr. Roy will admit that it is almost impossible to work a large mine on the single entry plan and carry the air current up to the faces, where there are fifty to seventy-five doors. When one is open, it cuts off the entire current of air. The law has not given us power enough to regulate the method of mining. This accident that was alluded to as occurring at the "Emma", did happen. I knew this shaft was going down into an old mine to make a second opening, and without

notice they started to hoist coal. They opened it without giving notice as the law provides shall be done.

MR. ROY: Will you allow me to ask a question? I understand that the adjoining mine never had safety gates. Is that true?

MR. SHORT: I wish to ask Mr. Roy which mine it is?

MR. ROY: The "Northern."

MR. SHORT: The statement is not true.

MR. HARRY: I verify it. They had a gas-pipe bar on there.

MR. KANE: I did not desire, when I spoke, to place any censure on the mine inspectors. My intention was to convey the idea that they had not sufficient power.

MR. ROY: I had no such intention, either. I am interested in having the law perfected. I am getting to be an old man now, and I take an interest in it, as you would in a law you were the father of.

SECRETARY HASELTINE: Just a word to put ourselves right. There is not a man living whom it hurts more to have a man killed in the State than myself; but as long as coal is mined, there will be people killed. This accident which has been alluded to, occurred because they failed to comply with the provisions of section 301, and did not notify us they were going to mine there.

Now, we have more powder used in Jackson county than in any other in the State, unless it is Stark. The vein of coal is thin, and while the air current is usually strong and meant to be carried right up to the face, and is carried up to the face (or provisions made for it), it is impossible to keep the smoke out, with the large number of men working in the mines.

Another feature is that the mines for the last two years have been more than usually full, two or three men for each ton of coal; and where there were provisions for one hundred men, they have jumped up to two or three hundred.

Mr. Roy seems to question the volumes of air reported. There is no man allowed or permitted to work who has not the full quota,

and more, circulating along his working face. If there is a discrepancy in any plant, steps are at once taken to remedy it; and ten thousand feet of air at the head of the entry or turned into the rooms is no uncommon thing in any portion of the State.

If the law was amended so as to make it efficient, it would be to provide the mode in which coal should be mined. While all are censuring the single entry system, the double entry is next to it from the point of censure. Mr. Roy's argument carries that out, because he holds up the mines at Steubenville, where the coal is mined on the County of Durham system. They have sweeter and purer air there and less trouble with powder smoke than in any of the mines in the State. I don't think I ever found over thirty thousand feet of air in any, but it was sweet and clean. They don't burn carbon oil, many use candles, and they don't use the quantity of powder. They have wide break-throughs and are able to move large volumes of air in slow currents.

Upon motion of Mr. Morris, duly seconded, it was unanimously voted to extend to the classes in mining, clay-working and economic geology of the Ohio State University an invitation to accompany the Institute on its annual excursion at the close of this meeting.

PRESIDENT ORTON: Captain Morris' motion came in at such a time that I do not know whether the discussion on the last paper was closed. I wish to say that we have two more papers to be read this evening, and it is getting late, so if there are any further remarks on this subject we will listen to them with the request that they be made brief. If there are none, I will call on Professor Ray, of the Ohio State University, to read his paper.